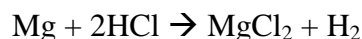


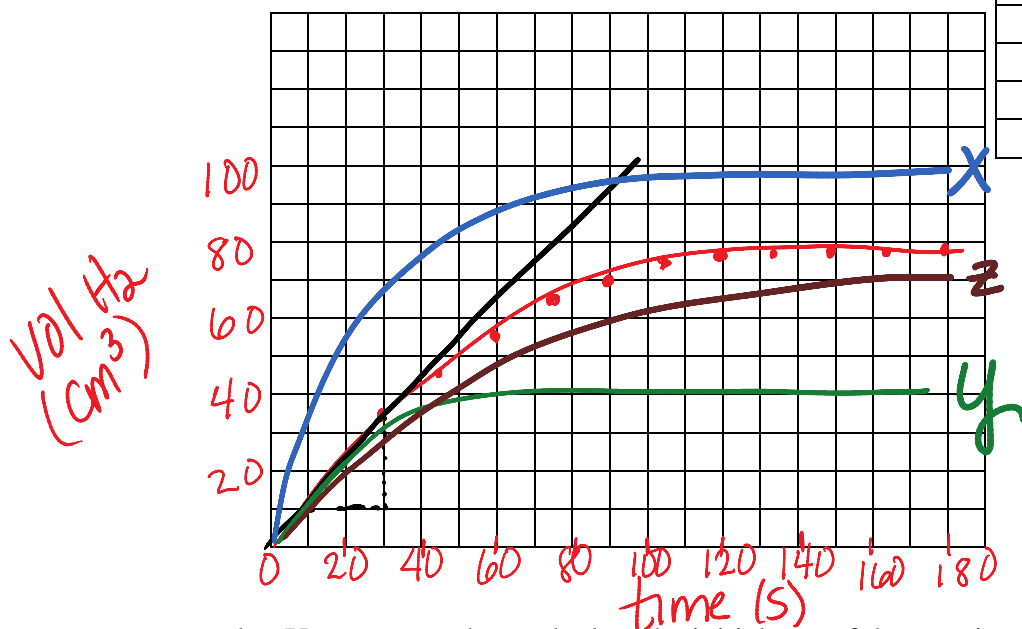
1. A series of experiments was carried out to measure the volume of gas produced when magnesium reacts with dilute hydrochloric acid.

In the first experiment, 0.10 g of Mg ribbon was reacted with 30 cm³ of 0.50 mol dm⁻³ HCl. The data for this experiment is recorded in the table. The reaction was carried out at 20°C. The equation for the reaction is:



- a. Draw a graph of this data and state and explain in terms of the collision theory how the rate of reaction changes with time.

Time / s	Volume of gas / cm ³
0	0.0
15	18.6
30	32.3
45	44.3
60	54.8
75	62.7
90	68.4
105	72.6
120	74.9
135	75.4
150	75.6
165	75.6
180	75.6



- b. Use your graph to calculate the initial rate of the reaction with units.

$$\text{slope of tangent} = \frac{35 - 10}{30 - 10} = 1.25 \frac{\text{cm}^3}{\text{s}}$$

- c. Calculate the average rate for the first 120 s.

$$\text{Avg Rate} = \frac{\Delta [\text{H}_2]}{\Delta t} = \frac{74.9 - 0}{120 - 0} = 0.624 \frac{\text{cm}^3}{\text{s}}$$

- d. The experiment was repeated under the same conditions, except that 0.10 g of powdered Mg was used. On the same set of axes you used in part **a** sketch the graph that would be obtained. Label this graph **X**.

↑ surface area ↑ rate *blue*

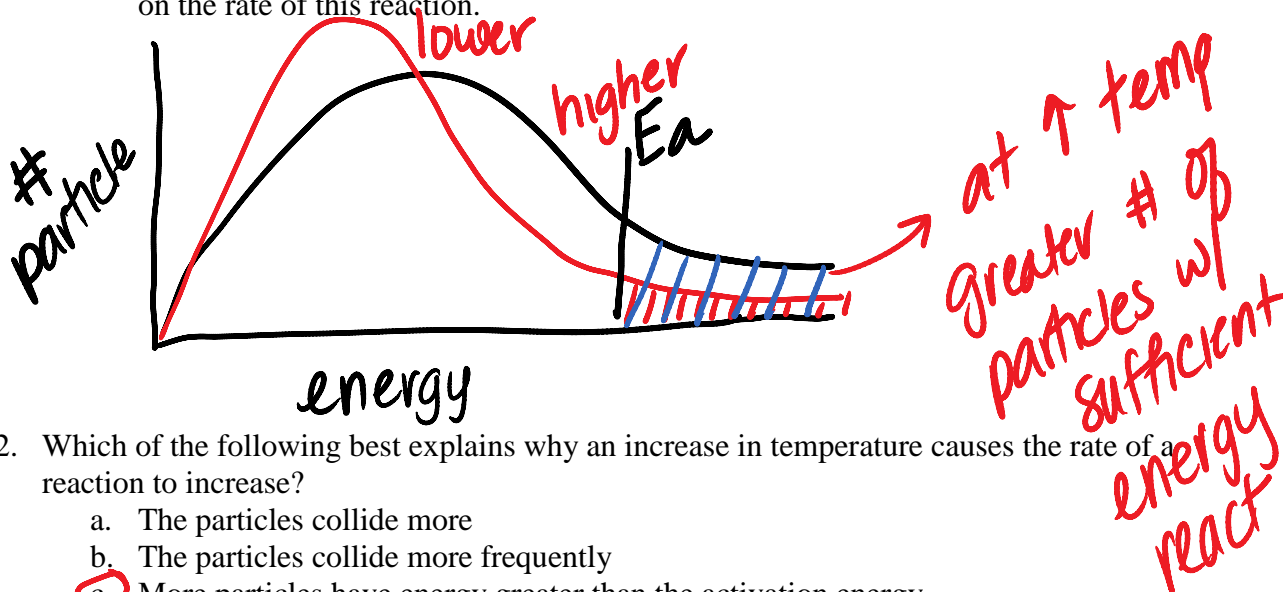
- e. The original experiment was repeated, except that 0.05 g of Mg ribbon was used. On the same axes sketch the graph that would be obtained. Label this graph **Y**.

↓ conc ↓ rate *green*

- f. The original experiment was repeated at 10°C. On the same axes sketch the graph that would be obtained. Label this graph **Z**.

↓ temp ↓ rate *purple*

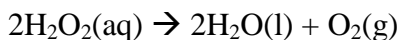
- g. Sketch the Maxwell-Boltzmann distribution for the original experiment and the experiment at 10°C and use this to explain the effect of a change in temperature on the rate of this reaction.



2. Which of the following best explains why an increase in temperature causes the rate of a reaction to increase?
- The particles collide more
 - The particles collide more frequently
 - ☒ More particles have energy greater than the activation energy
 - The activation energy is low at higher temperature

OLD IB TEST PROBLEMS

3. An experiment was carried out to measure the rate of decomposition of hydrogen peroxide according to the equation:



56.0 cm³ of gas was produced in 30.0 seconds. The average rate of reaction during this time was:

$$\text{Avg Rate} = \frac{56.0 \text{ cm}^3}{30.0 \text{ s}} = 1.87 \frac{\text{cm}^3}{\text{s}}$$

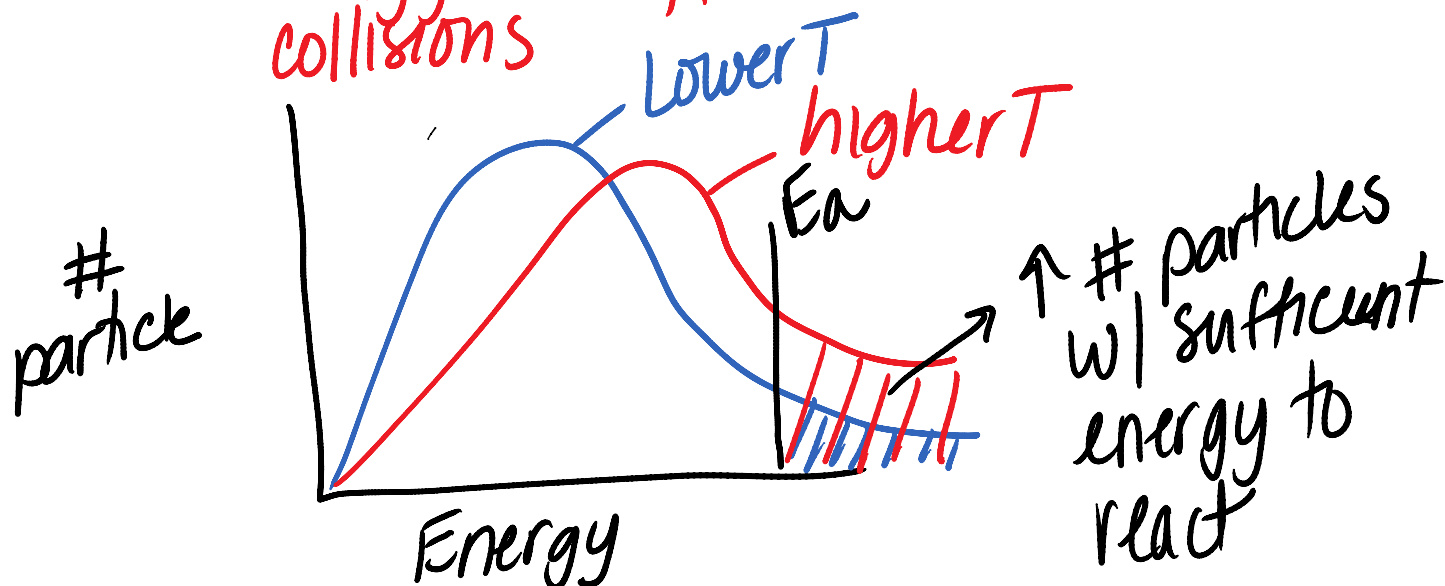
- a. 1.87 cm³s⁻¹
b. 28.0 cm³min⁻¹
c. 0.536 s cm⁻³
d. 112 min cm⁻³
4. Which of the following will **not** increase the rate of the reaction?
- $$\text{Mg}(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$$
- a. Increasing the surface area of the magnesium
b. Increasing the volume of hydrochloric acid used
c. Increasing the concentration of the hydrochloric acid
d. Increasing the temperature
5. In the decomposition of hydrogen peroxide, manganese (IV) oxide is a catalyst. Which of the following best describes the function of a catalyst and its mode of action?
- a. It speeds up the reaction by increasing the activation energy
b. It slows down the reaction by decreasing the collision frequency of particles
c. It speeds up the reaction by allowing the reaction to occur by an alternative pathway of lower activation energy
d. It speeds up the reaction by increasing the average energy of the particles
6. In the reaction between 1.00 g marble chips (calcium carbonate) and 25.0 cm³ hydrochloric acid, which of the following sets of conditions should give the fastest rate of reaction?

- a. 0.50 mol dm⁻³ HCl(aq) and small marble chips at 20°C
b. 0.10 mol dm⁻³ HCl(aq) and small marble chips at 30°C
c. 0.30 mol dm⁻³ HCl(aq) and small marble chips at 70°C
d. 0.50 mol dm⁻³ HCl(aq) and large marble chips at 30°C

7. Explain by reference to the Maxwell-Boltzmann distribution why the rate of a reaction in the gas phase increases as the temperature increases.

↑ rate due to ↑ temp is due to 2 factors

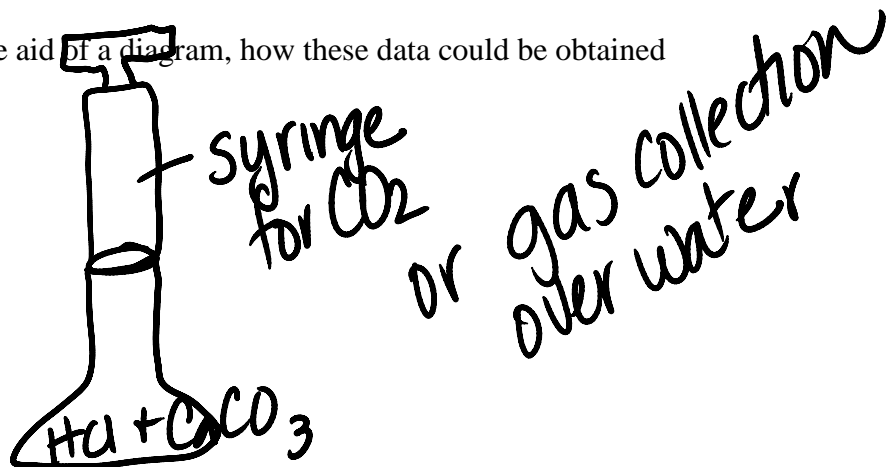
- ↑ temp, ↑ KE & are moving faster & collide more often
- ↑ temp will have more particles w/ energy > E_a , thus more successful collisions



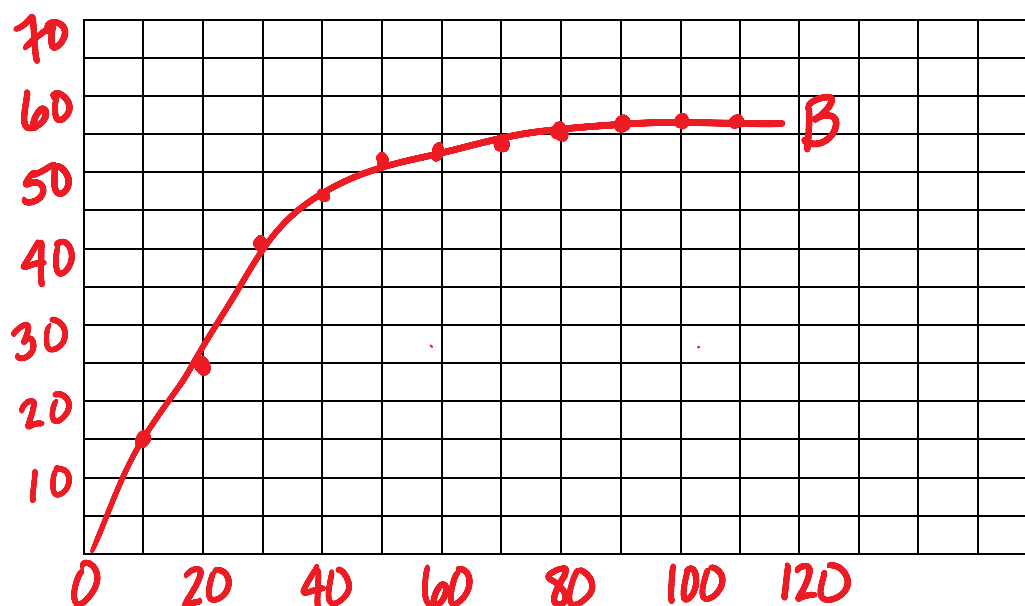
8. The data in the table below refer to the reaction:



- a. Explain, with the aid of a diagram, how these data could be obtained experimentally.



- b. Plot these data on graph paper and label the line **B**.



- c. Use the graph that you have plotted in part **b** to state and explain where the rate of reaction is fastest.

Time / s	Volume of CO ₂ produced / cm ³
0	0.0
10	16.0
20	30.0
30	41.0
40	47.0
50	51.0
60	53.5
70	55.5
80	56.5
90	57.0
100	57.0

Rate is fastest
at the beginning
(steepest slope)
this is because the
conc of the
reactants is greater
at the beginning so
more collisions